Lesson 6: Exploring the Nature of Energy Flow

Estimated time
(1-2) 50-minute class periods

Science CLEs
ME.1.I.a. Compare the mass of the reactants to the mass of the products in a chemical reaction or physical change (e.g., biochemical processes, carbon dioxide-oxygen cycle, nitrogen cycle, decomposition and synthesis reactions involved in a food web) as support for the Law of Conservation of Mass

ME.2.A. Forms of energy have a source, a means of transfer (work and heat) and a receiver

ME.2.F.a. ~~Classify the different ways to store energy (i.e., chemical, nuclear, thermal, mechanical, electromagnetic) and~~ describe the transfer of energy as it changes from kinetic to potential, while the total amount of energy remains constant within a system (e.g., biochemical processes, carbon dioxide-oxygen cycle, nitrogen cycle, food web)

EC.2.A. As energy flows through the ecosystem, all organisms capture a portion of that energy and transform it to a form they can use

EC.2.A.a. Illustrate and describe the flow of energy within a food web

EC.2.A.b. Explain why there are generally more producers than consumers in an energy pyramid

EC.2.A.c. Predict how the use and flow of energy will be altered due to changes in a food web

EC.2.B.b Explain the importance of the recycling of nitrogen, oxygen, and carbon within an ecosystem

IN.1.A.a. Formulate testable questions and hypotheses

IN.1.D.a. Communicate the procedures and results of investigations and explanations through:
- Oral presentations
- Drawings and maps
- Data tables (allowing for the recording and analysis of data relevant to the experiment such as independent and dependent variables, multiple trials, beginning and ending times or temperatures, derived quantities)
- Graphs (bar, single and multiple line)
- Equations and writings

Vocabulary
Energy
Kinetic energy
Potential energy
Photosynthesis
Primary production
Cellular respiration
Producers
Energy flow
Consumers
Food chains
Slot length limit
Food web
Detritivores
Decomposers
Keystone species
Trophic level
Energy pyramids

Objectives

1. Define energy and distinguish between kinetic and potential.
2. Describe the transfer of energy as it changes from kinetic to potential, while the total amount of energy remains constant.
3. Explain why energy is important to organisms.
4. Describe how most organisms obtain the energy they need to survive.
5. Explain how primary production is affected by light, temperature, moisture and nutrients.
6. Illustrate and describe the flow of energy through a food chain.
7. Illustrate and describe the flow of energy through a food web, including detritivores and decomposers.
8. Predict the effects of removing species from a food web.
9. Define keystone species and explain their importance in maintaining balance in an ecosystem.
10. Explain how trophic levels are used to construct energy pyramids.
11. Explain why energy available to organisms decreases as it moves up trophic levels.
12. Explain why there are generally more producers than consumers in an energy pyramid.

Resource Management Objectives

1. Describe how resource managers use their knowledge of primary production and energy flow to stock fish in ponds.
2. Explain why knowledge of keystone species is important in habitat management plans.

Essential Questions

1. Why are there usually fewer than five levels in an energy pyramid?
2. What is the impact of changing a piece of a food web?

Teacher Notes

Students should read *Nature Unbound* Chapter 6 before beginning Lesson 6 activities.

This lesson contains an outdoor activity that can be done in one or two class periods.

Outline of Answers to Objectives

See following page.

Essential Activities

Essential Activity 6.1—Caught in the Web
Essential Activity 6.2—Energy Pyramids

End of Chapter Assessment

Lesson 6 Questions and Answer Key

Summary

- Organisms need energy to grow, survive and reproduce.
- Most organisms obtain energy through photosynthesis or by eating other organisms.
- Primary production is affected by temperature, moisture and nutrients.
- Food chains show a specific pathway of energy flow in a community.
- Food webs are complex illustrations of interconnected food chains.
- Some species affect a food web more than others.
- Energy pyramids simplify food webs by sorting organisms into trophic levels.
- Only about five to twenty percent of energy passes from one trophic level to the next.

Outline of Answers to Objectives

1. **Define energy and distinguish between kinetic and potential.** (p. 70)
   a. Energy is defined as the ability to do work.
   b. Energy is grouped into two main categories of kinetic or potential.
      i. Energy in motion is called kinetic energy.
      ii. Potential energy is stored energy and has the potential to move.

2. **Describe the transfer of energy as it changes from kinetic to potential, while the total amount of energy remains constant.** (p. 70)
   a. Energy can't be created or destroyed but can change from one form into another. For example, water behind a dam is potential energy. Releasing some water to fill a lake changes the stored energy to kinetic energy.

3. **Explain why energy is important to organisms.** (p. 70)
   Everything an organism does requires energy. Life functions of organisms such as maintaining body temperature, escaping predators, growing new cells or pumping blood through the body all require energy.

4. **Describe how most organisms obtain the energy they need to survive.** (p. 71)
   a. Organisms get energy through consuming other organisms or through photosynthesis.
      i. Consumers get energy by eating other organisms.
      ii. Producers such as plants and photosynthetic organisms use kinetic energy from sunlight to combine molecules of water and carbon dioxide to produce glucose in the process of photosynthesis. Plant tissue is formed when glucose is combined with nitrogen and other elements to form proteins and nucleic acids. This process provides a form of energy that most organisms can use for growth, survival and reproduction and is called primary production.

5. **Explain how primary production is affected by light, temperature, moisture and nutrients.** (p. 72)
   a. The energy from sunlight is required for photosynthesis to occur. The rate of primary production is directly influenced by the amount of available sunlight. Limited amounts of sunlight limit the amount of primary production that occurs. Increased amounts of light produce an increase in the rate of primary production.
   b. The rate of primary production is influenced by temperature. When the temperature decreases, photosynthesis slows. As the temperature increases, the process of photosynthesis also increases (to a point). Photosynthesis generally occurs best from 16 degrees Celsius to 34 degrees Celsius.
   c. In the process of photosynthesis, molecules of water combine with carbon dioxide molecules to form glucose. Lack of water can hinder photosynthesis, which in turn, limits primary production.
   d. Nutrients such as nitrogen and phosphorus are required to form plant tissue. A lack of these elements can limit the growth of producers and the rate of primary production, particularly in aquatic ecosystems.

6. **Illustrate and describe the flow of energy through a food chain.** (p. 73)
    a. Food chains display the path of energy as it is transferred from producers to various consumers. As each organism is consumed, the energy is transferred into the tissues of the consumer.

7. **Illustrate and describe the flow of energy through a food web, including detritivores and decomposers.** (p. 75)
    a. A food web illustrates all the pathways the sun's energy might take as it is transferred from one organism to another in a community. Food webs show how food chains are interconnected and include detritivores and decomposers.
        i. Detritivores feed on dead organisms and excrete wastes. They break down dead organisms to smaller pieces. Examples of detritivores in a wetland are crayfish, worms and aquatic insects.
        ii. Decomposers feed on dead organisms and break down the nutrient molecules found in the organisms' tissues into simpler molecules that can be used by producers during photosynthesis. Examples of decomposers are bacteria and fungi.

8. **Predict the effects of removing species from a food web.** (p. 76)
    a. When one organism is removed from a community, all the organisms that eat that particular organism plus the organisms higher on the food chain will be greatly impacted. For example, if algae disappears from a wetland, snails and crayfish would be affected. In addition, the organisms that eat snails and crayfish would be affected.
    b. If a keystone species is removed, the flow of energy through the community will be greatly affected in various ways. For example, removing muskrats from a marsh will allow the cattails to dominate the marsh, and plant diversity will be diminished.

9. **Define keystone species and explain their importance in maintaining balance in an ecosystem.** (pp. 76-78)
    a. Species that have a stronger influence than other species on the way energy flows through a food web are referred to as keystone species.
    b. The loss of a keystone species in an ecosystem has a greater consequence on the flow of energy than the loss of other, less influential species.

10. **Explain how trophic levels are used to construct energy pyramids.** (p. 78)
    a. Trophic levels group organisms by the position they occupy in a food chain. Energy pyramids depict the amount of energy available at each trophic level. The shape of the pyramid shows that consumers at higher trophic levels have less energy to support them than consumers at lower trophic levels.
        i. The first level contains producers that convert the sun's energy into other usable forms of energy.
        ii. The second trophic level contains primary consumers—organisms that eat primary producers.
        iii. The third trophic level contains secondary consumers that eat primary consumers.
        iv. The fourth trophic level contains tertiary consumers that eat secondary consumers.
        v. The fifth trophic level is made up of quaternary consumers that eat tertiary consumers.

11. **Explain why energy available to organisms decreases as it moves up trophic levels.** (pp. 79-80)
    a. At the first trophic level, 15% of the sun's energy goes back to the atmosphere, 40% is converted to heat, 40% is used to move water through the plant, 4% is used for cellular reproduction and only 1% becomes available to primary consumers.
    b. At the second trophic level, some tissue can't be used and is excreted as waste; other digested tissue is used in cellular respiration or is lost as heat.
    c. Generally, only 5 to 20 percent of the total energy is passed to the next trophic level. The major portion of the energy is lost due to the following three reasons:
        i. The inability of organisms to digest certain tissues from organisms in a lower trophic level
        ii. The use of energy to keep the organism alive
        iii. The loss of energy as heat transferred to the environment

12. **Explain why there are generally more producers than consumers in an energy pyramid.** (p. 81)
    a. Primary producers generally outnumber consumers because producers support the consumers at all levels of the energy pyramid. Energy is lost as it moves through each trophic level, making less energy available to higher-level consumers. A greater number of producers is required to support the next trophic level. This explains why most food chains have five or fewer links.

Resource Management Objectives

1. **Describe how resource managers use their knowledge of primary production and energy flow to stock fish in ponds.** (p. 74)
   a. A pond's most important producers are microscopic plants called phytoplankton. Phytoplankton require carbon dioxide, water, sunlight and nutrients such as nitrogen and phosphorous. These nutrients wash from the soil and dissolve in pond water. In areas with high soil fertility there are more nutrients available, and primary production by phytoplankton is higher. Resource managers use information about the fertility of soils to identify the ideal amounts and variety of fish for stocking a pond. Richer soils can support higher levels of fish because the primary production will be higher. Soils with poor fertility will not support the same level of fish.
   b. Ponds often contain an overabundance of bass 20 to 30 centimeters in length. Biologists call this a stockpiled bass population. The bass get just enough food to stay alive, but not enough to grow very large. In this situation, resource managers may encourage increasing bass harvest by instituting a slot length limit. The length limit allows fish under and over a certain length, or slot, to be harvested. A slot length limit between 30 and 40 centimeters would encourage harvest of bass less than 30 centimeters and over 40 centimeters. All fish between 30 and 40 centimeters are released. Removing a large number of smaller bass makes more food available to the remaining fish.

2. **Explain why knowledge of keystone species is important in habitat management plans.** (p. 77)
   Knowledge of keystone species, like the prairie lizard (formerly known as the Northern fence lizard) on glades, will determine how to manage the habitat to promote that species and restore the community.

Essential Activity 6.1
Caught in the Web

Estimated time
(1-2) 50-minute class periods

Objectives
Students will be able to:
1. Describe how most organisms obtain the energy they need to survive.
2. Illustrate and describe the flow of energy through a food chain.
3. Illustrate and describe the flow of energy through a food web, including detritivores and decomposers.
4. Predict the effects of removing various pieces of a food web.
5. Define keystone species and explain their importance in maintaining balance in an ecosystem.
6. Explain how trophic levels are used to construct energy pyramids.
7. Explain why energy available to organisms decreases as it moves up trophic levels.
8. Explain why there are generally more producers than consumers in an energy pyramid.

Teacher Preparation
Have students work in groups of three or four to create food webs adding information they collect about decomposers and detritivores. The final project will be to create an energy pyramid.

Locate several different habitats in the schoolyard ecosystem. Assign groups to specific habitats to ensure all are represented. Discuss collection techniques with students. Discuss the pros and cons of (1) collecting specimens to take back to the classroom for identification and (2) recording organisms and releasing them immediately. Remind students that it is best to observe an area before disturbing it. Many animals will move away once they are disturbed. Moving into and observing an area quietly will improve and increase opportunities to observe organisms.

Materials
Student science notebooks
Pencils
Air thermometer
Insect nets
Forceps
Collection jars
Magnifiers
6.1 Investigation Cards (6 or 7 per student)
Field guides
Poster board
Yarn
Digital cameras and/or the camera feature of cell phones (*optional*)

Procedure

Part 1

1. Have students complete their science notebook headings and record questions they have during the activity.

2. Provide each student five *6.1 Investigation Cards*. Remind students that not all organisms need to be collected but that all organisms should be observed, described, recorded and placed in a trophic level.

3. Instruct students to begin by carefully observing their study area before they disturb it. Many organisms can be observed by quiet observation.

4. Divide students into small groups. Groups should be assigned to different habitats of the study site. Each student's set of five cards should represent the five different trophic levels. Move among groups and provide prompts to groups that are not including producers as organisms.

5. Students should complete their cards. If the common name of an organism isn't known, students should record distinguishing characteristics. Digital cameras may be used to record organisms and their characteristics. If an organism is collected, students should record the jar label number in the blank for the name.

6. Students should record any observations which may be helpful in identifying the organism's trophic level and relationship to other organisms in its food web. If necessary, include these prompts:
   a. Did you observe the organism collecting energy?
   b. Was the organism in a predator or prey role?
   c. Did you observe the organism interacting or associating with another organism?

Part 2

1. Have groups arrange their cards in a food chain. If necessary, provide prompts to ensure students have identified five trophic levels in each food chain.

2. Provide each group with one or two more *6.1 Investigation Cards*. Groups should return to their study area to look for decomposers and complete a card for any decomposers observed.

3. Groups should arrange their cards to create a food web. If necessary, provide prompts to remind students to include decomposers and/or detritivores.

4. In the classroom, each group should create a food web on poster board that depicts their habitat using digital photos or investigation cards. Yarn may be used to illustrate the numerous pathways through which energy flows among organisms.

5. Each group should present their energy pyamids to the class. Presentations should address the following questions:
   a. Are there organisms that are likely to be in the food web but were not observed?
   b. Is one organism more connected than others (keystone species)?
   c. What would happen if that organism (keystone species) were removed from the habitat?
   d. What would happen if half of the producer species were removed? What if 75% were removed?
   e. What might cause such a loss of producers and what implications might this have on individual organisms and on the entire habitat? How might this effect energy flow?
   f. In their schoolyard ecosystem, what human influences (positive and/or negative) affect the food web they presented?
   g. What questions do students have about their observations?

6. Display the food webs.

7. Students should compile information from the food webs to create a schoolyard ecosystem energy pyramid indicating where the energy goes. (See Figure 6.5 on page 80 of *Nature Unbound*.)

Wrap up

1. Review and discuss student findings.

2. List student questions and have students decide which questions are testable.

3. Discuss how they would create an experiment, field study or further observation on one of the testable questions.

Assessment

1. Check for completion and accuracy of investigation cards and energy pyramid.

Extensions

1. Predict food chains and food webs found in different habitats.

2. Create a poster, PowerPoint, etc. of these food chains or food webs.

3. Identify keystone species for each habitat.

6.1 Investigation Card

Habitat (name or description): _____

_____

Common Name/Description/Collection Jar Number: _____

_____

_____

Scientific Name: _____

Trophic Level: _____

Energy Source:_____

Who consumes this organism?_____

Use back of Investigation Card for other observations.

Question:_____

_____

6.1 Investigation Card

Habitat (name or description): _____

_____

Common Name/Description/Collection Jar Number: _____

_____

_____

Scientific Name: _____

Trophic Level: _____

Energy Source:_____

Who consumes this organism?_____

Use back of Investigation Card for other observations.

Question:_____

_____

Essential Activity 6.2
Energy Pyramids

Estimated Time
(1) 50-minute class period

Objectives
Students will be able to:
1. Illustrate and describe the flow of energy.

2. Explain how trophic levels are used to construct energy pyramids.

3. Explain why energy available to organisms decreases as it moves up trophic levels.

4. Explain why there are generally more producers than consumers in an energy pyramid.

Teacher Preparation
A large outdoor area will be needed for this activity. This activity will illustrate that, on average, ten percent of energy consumed is converted to bodily use and 90% is lost. The numbers used are arbitrary, but the percentage represents an average loss over various ecosystems. In the modified ecosystem on the student worksheet, the numbers are smaller to make the paper pyramid more manageable. In an actual ecosystem, the numbers are larger, reflecting a more accurate description of the energy in an ecosystem, but the paper needed would be immense. It may only be necessary for students to see this and not actually follow through on the construction of the actual ecosystem, or one model may be made with the entire class.

Have students work in groups of three or four to create visual representations of energy pyramids. Using the worksheet as a guide, groups will build paper pyramids which indicate energy loss at each trophic level. The final product will be the pyramids.

Materials
Student science notebooks
Pencils
Rolls of adding machine paper or toilet paper
Copies of *6.2 Energy Pyramid Worksheet* (one per group)
Calculators
Scissors
Colored markers
Poster board or butcher paper
Metric rulers and/or metric measuring tapes

Procedure

1. Have students complete their science notebook headings.

2. Have groups complete the *6.2 Energy Pyramid Worksheet* for the modified and actual ecosystems. Explain that in the modified ecosystem, the numbers are arbitrary but percentages are accurate for most ecosystems. At each trophic level, the lengths are multiplied by .1 (indicating 10% of the energy is available from the previous trophic level).

3. Have groups cut four pieces of adding machine paper or toilet paper, the length of each strip of paper should reflect the length of one of the four trophic levels as determined on the worksheet. These four strips of paper represent the four trophic levels of the modified energy pyramid. On a large piece of poster board or butcher paper, have groups place the strip of paper representing the producers on the bottom, then the primary consumers, secondary consumers, and finally, the tertiary consumers on top. Label and decorate (with examples of organisms) for each level of this pyramid.

4. Have groups repeat step 2 for the actual energy pyramid. Numbers will be larger, so the lengths of paper will be longer.

5. Have students display the pyramid on the ground. When completed, lay the modified pyramid next to it for comparison.

6. Have students summarize what they have learned in their science notebooks.

Wrap up

1. Discuss student findings and summaries.

2. Discuss what would happen if the producer level were decreased by 50%. What might cause such a loss, and what implications might this have on the energy flow through the entire ecosystem?

3. Display modified pyramids. Did students use examples from the same ecosystem?

Assessment

1. Check pyramids for completion and accuracy.

2. Check summaries in science notebooks for understanding.

Extension

1. Cave animals can only convert 2.5% of the energy for bodily use. Using that number (.025), have students create an energy pyramid for caves.

6.2 Energy Pyramid Worksheet

Directions: Fill in the worksheet, starting with the modified ecosystem. These numbers are arbitrary. At each level, use the number from the previous level in your calculations. Then, measure pieces of adding machine paper or toilet paper to represent each trophic level. Glue the levels onto a large piece of poster board or butcher paper, starting with producers on the bottom, then primary, secondary and finally, tertiary consumers. Decorate the paper with pictures or labels of plant and animal examples at each trophic level.

MODIFIED ECOSYSTEM

1st level—Producers: 640 mm

2nd level—Primary consumers: (640 mm X 0.1) = _____ mm

3rd level—Secondary consumers: (_____ mm X 0.1) = _____ mm

4th level—Tertiary consumers: (_____ mm X 0.1) = _____ mm

ACTUAL ECOSYSTEM

(with actual energy base 200X greater than the modified ecosystem)

1st level—Producers: (640 mm X 200) = _____ mm

2nd level—Primary consumers: (_____ mm X 0.1) = _____ mm

3rd level—Secondary consumers: (_____) mm X 0.1 = _____ mm

4th level—Tertiary consumers: (_____) mm X 0.1 = _____ mm

Lesson 6
End of Chapter Assessment

1. Which statement below describes energy?
   a. Energy is the raw material that creates change.
   b. Energy is required for organisms to grow new cells.
   c. Organisms can transform one form of energy into another.
   d. Energy is the ability to do work.
   e. All of the statements describe energy.

2. Which of the following statements provides an example of how energy is changed from kinetic to potential energy?
   a. A cell phone transforms the chemical energy in its batteries into electricity.
   b. A tree uses the sun's energy to transform water and carbon dioxide into glucose.
   c. Light waves produce heat.
   d. During cellular respiration, oxygen and glucose react to form carbon dioxide and water.

3. Give an example to explain how the total amount of energy remains constant within a system during the transfer of energy from kinetic to potential.

4. Explain how energy is important to organisms.

5. List two ways organisms obtain the energy they need to survive.

6. Formulate a testable question concerning primary production of an ecosystem. What variables might affect the rate of primary production?

7. Draw and label a diagram to illustrate the flow of energy through a food chain.

8. Explain the function of decomposers and detritivores in a food web.

9. Define a keystone species.

10. Suppose muskrats are overharvested from a wetland ecosystem. Predict how the use and flow of energy would be altered.

11. Which of the following statements explains why an energy pyramid generally has more producers than consumers?
    a. Energy is lost as it moves through each trophic level, making less energy available to higher-level consumers.
    b. When a producer is removed from a community, all the organisms that eat that particular organism plus the organisms higher on the food chain will be negatively impacted.
    c. Consumers at higher trophic levels have more energy than consumers at lower trophic levels.
    d. Almost 90% of the energy in the first trophic level is transferred to primary consumers.

12. Give examples of organisms at each trophic level and explain why they belong at that level.

13. Which of the following helps to explain why the amount of energy available to an organism decreases as it moves up trophic levels?
    a. The inability of the organism to digest certain tissues from organisms in a lower trophic level causes the energy to become fuel for decomposers.
    b. An organism uses some of the energy for life functions.
    c. As energy is transferred, some is lost as heat into the environment.
    d. All of the above

14. What actions might a resource manager take to resolve the problem of a pond with an overabundance of small bass?

Lesson 6
End of Chapter Assessment Scoring Guide

1. Which statement below describes energy?
   a. Energy is the raw material that creates change.
   b. Energy is required for organisms to grow new cells.
   c. Organisms can transform one form of energy into another.
   d. Energy is the ability to do work.
   e. All of the statements describe energy.
   Answer: e **(1 point)**

2. Which of the following statements provides an example of how energy is changed from kinetic to potential energy?
   a. A cell phone transforms the chemical energy in its batteries into electricity.
   b. A tree uses the sun's energy to transform water and carbon dioxide into glucose.
   c. Light waves produce heat.
   d. During cellular respiration oxygen and glucose react to form carbon dioxide and water.
   Answer: b **(1 point)**

3. Give an example to explain how the total amount of energy remains constant within a system during the transfer of energy from kinetic to potential.
   Answer: In the process of photosynthesis, plants obtain kinetic energy from sunlight. The energy doesn't disappear but is changed into different forms. The plant loses part of the energy as heat, and part is transformed into the potential energy of glucose. Another part of the energy is released into the atmosphere. The amount of energy did not change. **(4 points)**

4. Explain how energy is important to organisms.
   Answer: Organisms require energy to complete functions necessary for life. Those functions include maintaining body temperature, growing new cells, pumping blood through the body and escaping predators. **(4 points)**

5. List two ways organisms obtain the energy they need to survive.
   Answer: Organisms get energy through consuming other organisms or through photosynthesis. **(2 points)**

6. Formulate a testable question concerning primary production of an ecosystem. What variables might affect the rate of primary production?
   Answers will vary but should include one of the following factors: Light, temperature, moisture or nutrients. (2 points)

7. Draw and label a diagram to illustrate the flow of energy through a food chain.
   Answer: Diagrams will vary, but should include the path of energy beginning with producers and the transfer to various consumers. **(1 point)**

8. Explain the function of decomposers and detritivores in a food web.
   Answer:
   a. Decomposers feed on dead organisms and break down the nutrient molecules found in the organisms' tissues into simpler molecules that can be used by producers during photosynthesis. Examples of decomposers are bacteria and fungi.
   b. Detritivores get their energy by feeding on dead organisms and provide energy by excreting wastes. Examples of detritivores in a wetland are crayfish, worms and aquatic insects. **(4 points)**

9. Define a keystone species.
   Answer: Keystone species are usually one of the least abundant organisms in a community but have a disproportionate effect on the way energy flows through the community. **(1 point)**

10. Suppose muskrats are overharvested from a wetland ecosystem. Predict how the use and flow of energy will be altered.
    Answer:
    a. When one organism is removed from a community, all the organisms that eat that particular organism plus the organisms higher on the food chain will be negatively impacted.
    b. If a keystone species is removed, the flow of energy through the community will be adversely affected in various ways. For example, removing muskrats from a marsh will allow the cattails to dominate the marsh, and plant diversity will be diminished. **(2 points)**

11. Which of the following statements explains why an energy pyramid generally has more producers than consumers?
    a. Energy is lost as it moves through each trophic level, making less energy available to higher-level consumers.
    b. When a producer is removed from a community, all the organisms that eat that particular organism plus the organisms higher on the food chain will be negatively impacted.
    c. Consumers at higher trophic levels have more energy than consumers at lower trophic levels.
    d. Almost 90% of the energy in the first trophic level is transferred to primary consumers.
    Answer: a **(1 point)**

12. Give examples of organisms at each trophic level and explain why they belong at that level.
    Answer: Producers should include plants and other organisms that use photosynthesis to convert sunlight into chemical energy. Primary consumers should include herbivores that eat the producers. Secondary consumers should include omnivores and carnivores that eat the primary consumers. The fourth trophic level should include tertiary consumers that eat secondary consumers. The fifth trophic level should include quaternary consumers that eat tertiary consumers. **(4 points)**

13. Which of the following helps to explain why the amount of energy available to an organism decreases as it moves up trophic levels?
    a. The inability of the organism to digest certain tissues from organisms in a lower trophic level causes the energy to become fuel for decomposers.
    b. An organism uses some of the energy for life functions.
    c. As energy is transferred, some is lost as heat into the environment.
    d. All of the above
    Answer: d **(1 point)**

14. What actions might a resource manager take to resolve the problem of a pond with an overabundance of small bass?
    Answer: Ponds often contain an overabundance of bass 20 to 30 centimeters in length. Biologists call this a stockpiled bass population. The bass get just enough food to stay alive, but not enough to grow very large. In this situation, resource managers may encourage increasing bass harvest by instituting a slot length limit. The length limit allows fish under and over a certain length, or slot, to be harvested. A slot length limit between 30 and 40 centimeters would encourage harvest of bass less than 30 centimeters and over 40 centimeters. All fish between 30 and 40 centimeters are released. Removing a large number of smaller bass makes more food available to the remaining fish. **(1 point)**